

# SHAPE OF ORBITAL PATH

According to 'MATTER (Re-examined)'

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*Abstract:* In any system of macro bodies, relative considerations can provide only parameters of their relative positions. Use of reference frame, related to a static central macro body, causes planetary orbital path to appear as closed geometrical figure around the central macro body. As central macro body is a moving macro body; this does not reflect physical reality. Although this helps to explain cyclic phenomena, properties attributed to elliptical/circular planetary orbital paths are unreal. Due to constant linear motions of free macro bodies in space, it is practically impossible for a free macro body to orbit around another, in any type of closed geometrical path. However, they may orbit about each other and follow a common median path in space. Real orbital path of a planetary body is wavy about median path of central body, with the planetary body moving to front and rear of central body, cyclically.

*Keywords:* Orbits, Planetary orbits.

## Relative motions:

Since no absolute reference is currently available, in physics, we use relative frames of references. By using a relative frame of reference, we assume certain region or a particular macro body is static (or is in assumed steady state of motion) and use relative parameters of other macro bodies, with respect to the static reference, for all purposes in mechanics. An alternative concept, presented in MATTER (Re-examined), envisages a real universal medium structured by matter particles and which fills the entire space to encompass all 3D matter-bodies. As universal medium is normally homogeneous and static, it can provide an absolute reference for all actions and movements of all macro bodies.

In nature, no 3D matter-macro body can remain static in space. To survive, it has to have translational motion with respect to universal medium. Each macro body has certain inherent motion and appropriate magnitude of work (kinetic energy) associated with it. By choosing a macro body as a

(static) reference, in that instant, we wipe-out whole of reference macro body's kinetic energy, associated with its particular motion. Simultaneously, we modify magnitudes of kinetic energies associated with all referred macro bodies. Although this is an unreal situation, it is convenient for general understanding of mechanics and mathematical analysis with respect to relative positions. When we start assigning reality to resulting parameters, other than relative positions, it invariably distorts ensuing theories and physical laws.

Parameters of macro bodies or paths traced by them in their motion, as considered in the above situation, are unreal with respect to static universal medium. These parameters have no relation to real movements or other parameters of considered macro bodies in absolute space, except their relative positions. Theories or mathematical treatments, using these apparent paths (geometrical figures) of moving macro bodies, represent unreal circumstances. They can, at the most, indicate assumed or imaginary results, which may coincide with our observations. They are always in relation to the steady (immobile) state of the chosen reference, within a system of macro bodies. These apparent or imaginary parameters cannot provide results for real physical actions.

A spinning macro body can be assumed as a static reference provided the observer is assigned with imaginary motion in a path around the reference macro body in opposite direction at equal angular speed. By doing so, magnitude of kinetic energy of spinning macro body is reduced to zero and observer is given appropriate magnitude of kinetic energy to maintain his apparent motion. Any action on reference macro body's spin motion by an external effort will appear to produce its results on observer's apparent motion rather than on state of (motion of) reference macro body. In order to maintain static state of reference macro body, it is necessary to refrain from any change in its static state (of motion). All real changes in its state of motion are born by apparent motion of observer. An external effort, acting on observer can change his state of motion. This change will be born by observer, himself.

Calculations, based on observer's apparent (relative) motion can give correct results with respect to their relative positions, for state of macro bodies within the system in same region of space. These results are true only within the system and it will not constitute physical reality. However, we must concede to the fact that when an external effort acts on reference macro body, resulting real action is only in magnitude of additional work (kinetic energy) associated with it and corresponds to change of its state (of motion). Although external effort appears to have changed kinetic energy associated with observer, in reality, external effort could change only kinetic energy associated with reference macro body. When an external effort acts on reference macro body, real action is only in change of state of (motion of) reference macro body. And when external effort acts on observer, real action is only in change of state (of motion) of observer. However, as reference macro body is assumed static, in both cases apparent changes are in magnitude of kinetic energy and corresponding state of (motion of) observer.

Real physical action of a small linear effort on observer, towards reference macro body, is to move observer towards the reference macro body. However, in the case considered above, apparent motion and speed of motion of observer encompasses both real physical action and apparent motion of observer. Observer apparently moves in a resultant direction at a resultant speed. Magnitude of resultant apparent action is greatly influenced by direction of applied effort. This does not correspond to real physical action on observer.

An apparent action on a macro body within a system, which is related to a steady reference, may be considered real only within the framework, limited within the system in the same region of space. This is not real physical action in nature, with respect to absolute reference. Real physical actions can take place only with respect to absolute reference. Only a static universal medium can provide an absolute reference. If macro bodies are in different regions of space with differing properties of universal medium, this type of assumption may not work well.

Relative considerations can give right results only in determining relative positions of macro bodies, considered. They are unable to provide real parameters of other states of macro bodies (size, work-done, temperature, pressure, matter content, kinetic energy, etc.) or shapes of their paths.

Figures, in this article, are not to scale. They are depicted to highlight points presented.

### Linear motion of a rotating macro body:

Linear and rotary motions of a macro body are entirely separate. Each of them is produced by separate set of additional work in macro body's matter-field. However, each point on a linearly moving rotating macro body has its own path of resultant motion. Its motion and path appear as resultant of linear and rotary motions of macro body. In figure 1, 'A' shows a rotating macro body that has no linear motion. Centre point of the macro body 'O' is steady in space. Point P on its periphery traces a circular path, as shown by the circle in dashed line. Let the macro body develop linear motion, as is shown by 'B' in the figure 1 and its centre of rotation moves from  $O_1$  to  $O_2$  at a constant linear speed, while macro body turns through one revolution. Point  $P_1$  on its periphery traces a loop, as shown by black curved line starting from  $P_1$  and ending at  $P_2$ .

'C' in figure 1 shows the rotating macro body moving at a higher linear speed. Centre of rotation of macro body moves linearly through a larger distance from  $O_1$  to  $O_2$ , while the macro body turns through one revolution. Loop traced by a peripheral point becomes narrower as linear speed increases, for same rotary speed. 'C' shows the path of the peripheral point during one rotation of the macro body.

Continuous loops in black from  $P_1$  to  $P_n$  in 'D' shows a continuous path traced by the peripheral point in space, while centre of rotation of rotating macro body moves linearly from  $O_1$  to  $O_n$  along line XX. As linear speed of macro body increases, in relation to its rotary speed, the loops in the path of peripheral point gradually becomes narrower until the loops altogether disappear at a stage. At this stage, macro body's linear speed equals  $n$  times the radius of the rotating macro body (distance of the peripheral point from the centre of rotation of the macro body) during every rotation of the macro body. Black series of semi-circular paths 'E' in figure 1 shows curved path traced by a peripheral point. Resultant path of peripheral point consists of semi-circular curves with their

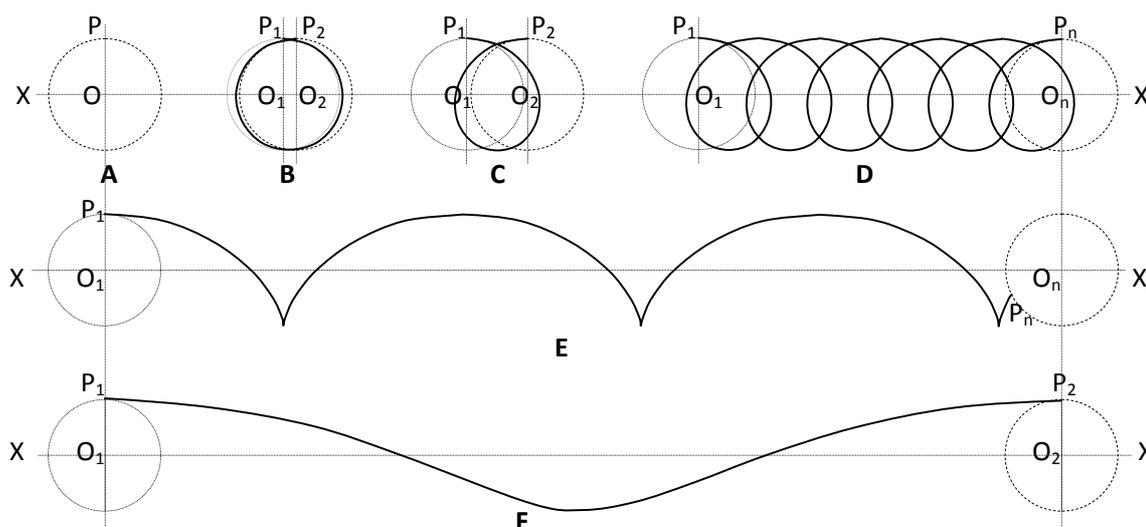


Figure 1

convex sides in same direction. Path starts at  $P_1$  and proceeds to  $P_n$  in 'E', while the centre of rotation of rotating macro body moves linearly from  $O_1$  to  $O_n$  along line XX.

As the linear speed of macro body exceeds this value, no point in macro body has motion in reverse linear direction. All points in macro body have displacements in forward direction. Requirements that points in a macro body on opposite sides of centre of rotation have motion in opposite directions are no more satisfied. No point in macro body has circular or elliptical path in space. All points in macro body move in forward linear direction only. However, with respect to any point in macro body, all other points in its plane of rotation, appears to move in circular path around the point of reference.

As linear speed of rotating macro body increases, semi-circular path of peripheral point expands to become a wavy path about the line of linear motion of centre of rotation, as shown by black curved line, 'F', in figure 1. Path of peripheral point in space traces a wavy curve from  $P_1$  to  $P_2$ , while the centre of rotation of macro body moves from  $O_1$  to  $O_2$  along line XX, during one rotation of macro body. At lower linear speeds, difference between segments of curved path (on either side of the linear path) is large. As linear speed of macro body increases (for same rotary speed), lower segment becomes larger and difference between upper and lower segments of curve reduces.

Although, depending on macro body's linear speed in relation to its rotary speed, peripheral point traces curves of loops, semi-circular curves or wavy path in space, it still moves in a circle with respect to centre of rotation of macro body. Motion of peripheral point in a circular path is apparent only to an observer situated at the centre of rotation of rotating macro body. Circular path of peripheral point, noticed by observer, is an illusion due to the observer not considering his own linear motion in space. In fact, every point in rotating macro body, moving in linear path, appears to move around every other point in same macro body. This is a false impression, created by choosing a moving point as a reference. Every point has its own independent path in space. Other than when the rotating macro body has no linear motion, path of the peripheral point does not trace a closed geometrical figure in space.

Center of rotation of macro body has linear motion along straight line, XX as shown in figure 1. For an observer, situated at one of its peripheral point, centre of rotation of macro body appears to move around his location. He cannot observe his own true motion in space. He also cannot observe linear motion of the rotating macro body (centre of rotation). Observed motion of centre of rotation in a circular path around peripheral point is an illusion.

Since both, apparent motion of peripheral point in circular path around centre of rotation and apparent motion of centre of rotation in circular path around peripheral point are only illusory motions; no true physical law can be based on them. Such illusory motions cannot be considered as proof of scientific laws. Observers, simultaneously situated at both these points have apparent motions contrary to each other's. None of them can observe true motion of points on rotating macro body, in space. Real paths of any point on a linearly moving-rotating macro body can be viewed only from an external point. Origin of frame of reference has to be outside the macro body.

A rotating macro body's integrity keeps relative positions of its peripheral points with respect to its centre of rotation. Its integrity provides certain attachment between these points. All through their displacements, distance between centre of rotation and a peripheral point remains constant. Each of these points can appear to move in circular paths around another point. Therefore, in any system of macro bodies, where distance between two is always kept constant (by some means irrespective of macro bodies' motions) and where each of the macro bodies appears to move in circular path around each other, above given explanations are valid.

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## Shape of planetary orbital paths:

As recently as few centuries ago, earth was believed to be the centre of universe. All other observable celestial macro bodies were assumed to revolve around earth. Developments in geometry and mechanics made this belief irrational. Attempts to depict paths of even the nearest celestial macro bodies were unsuccessful or illogical, until Johannes Kepler formulated his first and second laws on planetary motion (by analyzing observations by earlier astronomers) in year 1609 AD. First law states that '*All planets move about the Sun in elliptical orbits, having the Sun as one of the foci*'. First law gives the shape of the orbital path and the second and third laws, which depend on the first law, give mathematical properties of this path.

Shapes of planetary orbits were categorically stated as elliptical. (Circle is a special ellipse). Neither why such motions should take place nor a mechanism of planetary motions were proposed by these laws. Choice of location of sun, out of two foci of ellipse, was also not explained. In short, Kepler's laws were formulated on the basis of empirical evidences only. They had no scientific base. Planetary orbital paths were depicted as they would appear to an observer, placed on static sun. These were assumed as true paths of the planets in space.

While formulating his laws on planetary motions, Johannes Kepler used observations only for few planets in solar system. Although, the moon is the nearest celestial macro body to earth and its orbital path was much easier to observe, it was left out. Probably, due to realization that moon, a satellite, could not execute an elliptical orbit around moving earth. His planetary laws are applicable only to the observed orbits of planets around a static sun. Observed orbital paths are what the observer sees, without considering his own state of motion. An observer, placed on a static sun sees all planets in solar system as orbiting around sun. Similarly an observer in any of the planets will observe all outer planets and the sun orbiting around him. Standing on earth, we see that sun, outer planets and moon orbit around us in complicated geometrical paths. All these orbital motions are mere appearance.

Although a planetary body appears to move in orbital path around a central body, in reality, it has independent motion of its own. Gravitational attraction towards central body causes a planetary body's path to deviate from straight line, to move about and along with central body in its motions. Since a planet is very small, compared to central body, deviations in planet's path are more prominent. When these deviations are considered about a static central body, orbital path of a planet appears around central body. This is apparent orbit of planet, which we observe in everyday life. Similarly, relative to an assumed static planetary body, apparent direction of motion of central body is around the planet. Few centuries back, when earth-centered universe was in prominence, this apparent motion was considered true. Later as science progressed, idea of a heliocentric universe came into prominence. Earth, orbiting around sun, is considered true in a heliocentric universe. Although we now know that, the sun is no more a static macro body at the centre of universe, our view of planetary orbits in a heliocentric solar system has not changed.

Apparent planetary orbits can be assumed around any reference point, within a planetary system. Since we consider instantaneous parameters of planetary bodies, for most of all practical purposes of predictions (of annually) re-occurring phenomena, apparent orbits (relative positions) provide accurate results. Although most astronomers are aware of apparent nature of elliptical orbital paths, they still consider apparent orbit as true orbital path of a planet. Kepler's laws on planetary motion and the elliptical planetary orbits are routinely used in conjunction with many multi-body problems including moon's orbital path, which was not considered for original planetary laws. Although mathematical treatments of apparent actions may produce results that suit apparent phenomena, they cannot always describe real facts.

We must consider that Kepler's 'laws of planetary motion' were formulated at a time, when

phenomenon of gravitation and phenomenon of 'central force' were unknown. At that time, even heliocentric nature of solar system was not an accepted fact. What Kepler has done is to formulate laws to suite observed locations of planets about sun, which was considered as static in space. No interactions or efforts between central body and planets were considered as cause of their relative motions.

Kepler's laws on planetary motions came into prominence and were widely accepted after they were used to verify and establish Newton's 'laws of motion' and the 'law of universal gravitation'. Newton's theories provided much needed cause and an imaginary mechanism for planetary orbital motion around a central body. Although, Newton clarified that planetary orbital paths (under 'central gravitational force') need not always be elliptical but they can also be parabolic or hyperbolic, general shape of a planetary orbit is accepted as an elliptical curve, around sun (central body).

Belief in elliptical planetary orbits around their central bodies played a crucial role in establishing the current theories on motion. It is from these closed geometrical figures of planetary orbits around a central body that proofs of contemporary gravitational laws were derived. Power of these laws to explain and predict various phenomena (with respect to relative positions) were confirmed later. This made Newton's 'laws of gravitation' and 'laws of motion', foundations of quantitative mechanics; all the while forgetting that mathematical treatments, used for their validation, are apparent planetary orbital motions, as observed around an assumed static central macro body and not true orbital paths of planets in space, about their central body.

Even relativistic mechanics subscribe to planetary orbital paths around central bodies. It suggests curvature of space near a very large macro body as the cause of planetary orbits rather than an 'attractive force' between planetary and central bodies.

### **Orbital motion:**

A planetary system is formed by a group of large macro bodies in space. They move together along a median path, while individual macro bodies have independent relative motions within the group. Planetary system that includes sun is solar system. Path of each macro body in the system is affected by presence of all other macro bodies in the group. We may, for the time being, neglect effects on their paths by the presence of other macro bodies in space, outside the group, as they are very small. There may also be smaller macro bodies called satellites in a planetary system. Satellites being very near to planets, they form (sub) planetary system with their mother planet, within the larger planetary system. Largest macro body in the group has its path nearest to median path and its path is least perturbed. This macro body acts as leader of the group and it is called central body of planetary system. All other macro bodies in planetary system move along with central macro body, while their paths are perturbed by presence of all other macro bodies in the system. For explanations below, we shall consider a planetary system containing a central body and one planetary body.

A planetary system is essentially a part of a galaxy. All stable galaxies are static in space. Galaxies are rotating systems of macro bodies with no translational motion [1]. Hence, a planetary system in a galaxy traces a circular path around galactic centre. Median path of planetary system is a very large circle around galactic centre. Largest macro body in planetary system acts as leader of the group and it is the central body of planetary system.

With reference to planetary body, central body appears to orbit around planetary macro body and with reference to central body, planetary body appears to orbit around central body. Disregarding eccentricity of an orbital path, distance between central body and planetary body remains constant. By these characteristics, a planetary system functions as a rotating macro body, moving in linear path. Planet takes the place of a peripheral point and central body takes the place of centre of rotation, in the explanation given above on the 'linear motion of a rotating macro body'.

Median path of planetary system is a very large circle around galactic centre. A small part of this very large circle is considered as a straight line for explanations.

Actions of 'central force' on a planetary body and orbital motion it causes are independent of all other macro bodies, including central body. Role of central body or any other macro body in vicinity is to limit extent of universal medium, acting on one side of planetary body. Rest of all actions on planetary body are performed by universal medium. Although planetary body appears to move in orbital path around a central macro body, in reality, it has an independent path of motion of its own. Gravitational attraction towards central body causes its path to deviate from straight line to move it about and along with central body. Due to gravitational actions, orbiting planetary bodies appear to influence direction of each other's motion and create perturbations in their paths. Since planet is very small compared to central macro body, deviations in its path are more prominent. When these deviations are observed about a central body that is assumed static in space, path of planetary body appears as (apparent) orbit around central macro body.

Circular or elliptical orbital motion is apparent only with respect to participating macro bodies. With respect to absolute reference, planetary body does not orbit around central body. Path of a planetary body's motion is wave-like, along central body's path, planetary body periodically moving to front and to rear of central body. In figure 2, path of the central body is shown by arrow in grey line. This path, also, is wavy to a smaller extent, curving in same directions as the path of planetary body. Arrow in black wavy-line shows planetary body's orbital path. Unevenness of curvature of path on either side of central body's path (in the figure) is due to different scales used for linear and radial displacements.

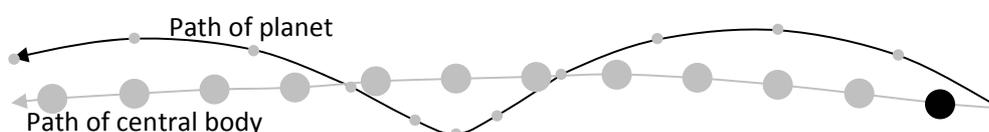


Figure 2

Path of a satellite of planet is wavy-line about planet's path. Central body and planetary body are shown by black circles and their future positions are shown by grey circles. In this sense, it can be seen that planetary body (or satellite) orbits around centre of central body's curved path and wave pattern in its path is caused by presence of central body. Such changes in the path of a free macro body may be attributed to perturbations caused by presence of nearby macro bodies. These perturbations look like orbital motion around central body, only when they are referred to an assumed static central body in a relatively small system of macro bodies. This argument can be carried further to show that with respect to absolute reference there is no natural orbital motion (around central bodies) at all, except orbital motions of macro bodies around (static) galactic centres.

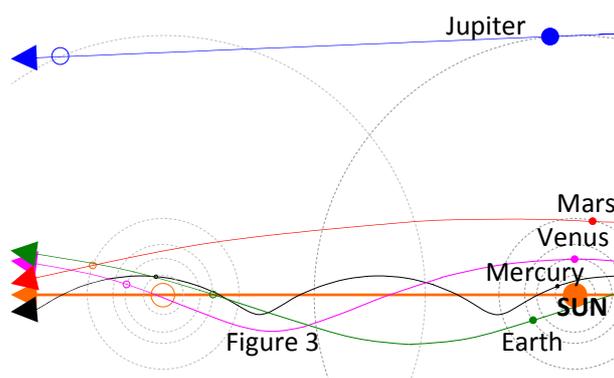
Although it is not generally acknowledged, shape of planetary body's orbital path is wavy about path of its central body. Both, planetary body and central body (and satellite) move in same direction about same median path in space. Since circular/elliptical orbital motion is an apparent phenomenon, either of the macro bodies can be considered as central body and the other as its planetary body. Planetary laws are equally valid in either case. Although it is generally stated that earth orbits around sun in eastward direction, it is equally valid to state that "sun orbits around earth in westward direction". However, when more than two macro bodies are considered as a

single system, it is more convenient to take common and most prominent macro body as central body and to take other bodies as planetary or satellite bodies.

A planetary body moves in same direction and along with its central body. It is only when we imagine reversing the direction of planetary body's motion, on one side of central body's path, we can get a geometrically closed figure for planet's apparent orbital path. This is something we unintentionally do. It coincides with our observations and general beliefs. It is a good assumption to have definite reference points on orbital paths, to predict cyclically varying phenomena. Even with these manipulations, shape of an apparent orbital path is oval with a single focus rather than an ellipse with two foci.

It is an established fact that sun is a moving macro body in space. By simple mechanics, it is physically impossible for a free planetary body to orbit around a moving central body, in any type of geometrically closed path. Both, circle and ellipse, are closed geometrical figures. Hence, elliptical planetary orbital paths (closed geometrical figures) around sun are false or apparent. Yet, no text books, atlases or any other type of literature agrees to the fact that planetary orbital paths are not circular or elliptical. Even the suggestion of non circular/elliptical planetary orbital path invites venomous criticism. Circular or elliptical planetary orbits around sun are apparent structures. They are what an observer on the static sun would notice. They do not exist in reality.

Figure 3 shows real orbital paths of inner members of solar system. Planets and sun, shown in the figure, are not to scale. Eccentricities of orbits are ignored. Relative positions of sun and planets, shown on right, are as on 3<sup>rd</sup> May 2002 [Reference: ESA Website]. Galactic centre is on lower side and solar system is depicted as revolving in anti-clockwise direction around galactic centre. Arrows at the ends of orbital paths show directions of motion of sun and planets. Path of the sun is shown as a straight line and its perturbations, caused by planets, are not shown in figure. Curved segments of planetary orbital paths, below sun's path (towards galactic centre), appear narrower because of very small scale of distance, used in figure. It can be seen from the figure that sun and planets move together along a common median path around galactic centre.



Macro bodies in the system cause perturbations to paths of all members. These perturbations, when observed with respect to any member of the system (which is presumed to be static), gives rise to apparent orbits of closed geometrical (circular or elliptical) figures around the member, which is assumed static. Apparent orbits are shown by grey dashed lines around sun. Dim set of figures on left shows relative positions of members of the system and their apparent orbits, five months later. Similar apparent orbits and planetary system can be built about any member of the system. They are imaginary. Until last days of 16<sup>th</sup> century A.D., solar system was considered with earth based apparent orbits. Later on; due to popularity of Kepler's planetary laws and Newton's support to the same, present system of heliocentric apparent orbits for the solar system came into prominence. However, imaginary nature of these orbital systems continues to be disregarded even after realising movement of central body in space. All macro bodies in asteroid belts are also planetary bodies with respect to sun. Their real orbital paths, in asteroid belt, are similar to planetary orbits about the sun.

Figure 4 shows the real orbital path of moon (a satellite) about earth. Orange circle shows sun and orange arrow shows sun's path as a straight line. Green circle shows earth and curved green arrow shows earth's real orbital path for five lunar months. Blue wavy arrow shows real orbital path of moon. Black dashed circle around sun shows apparent orbit of earth. Black circle in dashed line around earth shows apparent orbit of moon around earth. Lower parts of real orbital path of moon about earth are narrower because of very small scale of distance chosen for figure. Figure is not according to any particular scale. Relative positions of sun, earth and moon are shown as for full moon days. Dim figures, to left, show relative positions and apparent orbits of earth and moon for subsequent full moon days. Eccentricities of apparent orbits are not considered. Real orbital paths of all satellites about their corresponding planets are similar.

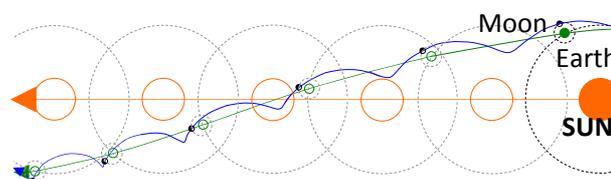


Figure 4

Some planets are found to have many smaller macro bodies orbiting about them. These, when depicted in their apparent orbits, make picturesque rings about the planets. However, their real orbits are similar to orbital paths of satellites about the planets. These macro bodies form a swarm around planetary body and move along with it in its motions. Figure 5 shows real orbital paths of these macro bodies about a planet. Figures on the right show relative positions of macro bodies and their apparent orbits. Orange circle shows sun, black circle shows planet and coloured circles show three smaller macro bodies in the ring, situated in same radial line from the planet. Orange arrow shows path of sun in a straight line. Black curved arrow shows real orbital path of planet. Coloured curved arrows show real orbital paths of smaller macro bodies in the rings. Dim figures, on left, show relative positions of macro bodies and their apparent orbits after lapse of certain time.

Planetary bodies have lower angular speeds, with respect to their central bodies, as their distance from central body increases. Their orbital paths cross each other at different places in space. Due to their different angular speeds, there is a possibility for any two planets in a planetary system (or for any two satellites of a planet) to come very near to each other. At certain point of time in future, it is possible for any two planets in a planetary system (or for any two satellites of a planet) to collide into and destroy each other. In case of smaller macro bodies, forming rings about a planet, they have identical angular speed with respect to their parent macro body. This prevents them from colliding into each other during motion along with their central body.

This swarm of smaller macro bodies about a planet also obey all rules of planetary motions. Only those smaller macro bodies in the swarm, which are in (or very nearly in) orbital plane of planetary system can survive in the rings, as explained later in this article. All macro bodies, which do not conform to planetary laws, are automatically removed from the system by mutual collisions or rejections. Hence, apparent rings about a planetary body are very thin and exist around planet's equator. Although, they are depicted

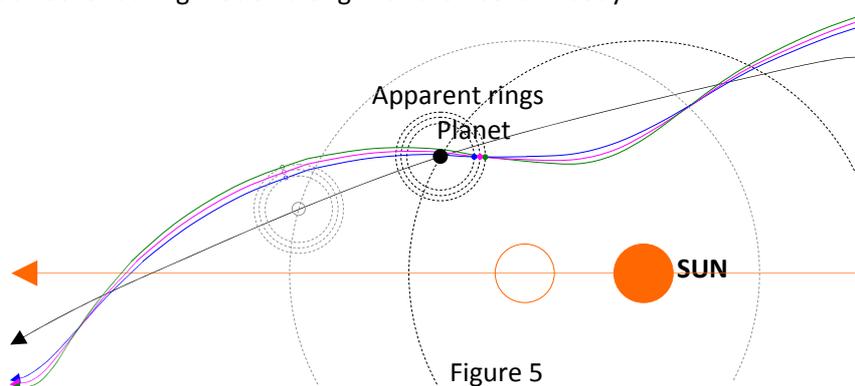


Figure 5

as rotating around the planet, they also move along with the planet in its linear motion as shown by coloured curved lines in figure 7. Since their angular speed is the same, linear speeds of these macro bodies increase as distance from planet increases (within escape velocity corresponding to planet). Due to centrifugal action, caused by their angular speeds, larger (by matter content) macro bodies tend to distribute farther from planetary body and smaller (by matter content) macro bodies remain near to planet's surface.

Acceptance of wavy-nature of planetary orbital paths can give simpler and logical explanations to many of the puzzling problems in cosmology, like; formation of planetary system, coplanar locations of macro bodies in a planetary system, mechanism of planetary spin, higher spin speeds of equatorial region of certain planetary bodies, displacements of tides from local meridian, precession of elliptical apparent orbits, apparent lengthening of solar days, etc. All assumptions, based on the elliptical nature of planetary orbits (like: multi-body problem, stellar aberration, etc.) will become invalid.

### **Conclusion:**

Elliptical/circular planetary orbits around a central body are apparent geometrical structures, developed from relative considerations and appearance of planetary motions to an observer (assumingly) based on static central macro body. They are created to explain relative positions and observed movements of planets about a (static) central body. In reality, a planet moves along with its central body in a wavy path about median path of planetary system around galactic centre, alternatively moving to front and rear of central body. A real orbital path does not form a closed geometrical figure.

### **Reference:**

- [1] Nainan K. Varghese: *MATTER (Re-examined)*, <http://www.matterdoc.info>

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